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Rigidities and adjustments of daily prices to costs: Evidence from supermarket data*

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Abstract

We assess the extent of inertia in grocery retail prices using data on prices and costs from a large supermarket chain in Colombia. Relative to previous work our analysis benefits from the daily frequency of the data and the availability of reliable replacement cost data. We uncover evidence supporting the existence of significant nominal rigidities in reference prices (three months) and even more so in reference costs (about five months). There is evidence that the price and cost rigidities differ depending on the type of product, being on average smaller in the case of perishable goods. Using an Error Correction Model framework, we examine the path of prices relative to costs, to determine the speed of adjustment of prices to shocks.

JEL Classification: C32, E31, L11, L81

Keywords: nominal rigidities, prices, costs, grocery trade, error correction.

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1 Introduction

This paper contributes to the macroeconomic literature on nominal rigidities by providing evidence on relative movements of price and cost changes for a variety of grocery items, based on a detailed and unique micro data set of daily grocery prices and costs from a major supermarket chain in Colombia. According to the macroeconomic literature, nominal rigidities play an important role in explaining key economic processes, such as the dynamic relationship between money, real output and prices, and the evolution of retail price inflation over time; see e.g. Taylor (1999). Traditionally, nominal rigidities have been modelled in the macroeconomic literature as "sticky" prices, that is prices that do not respond quickly to exogenous shocks, such as unanticipated economic policy interventions or international events. In turn, a wide range of papers have debated the question of whether final goods prices are sticky or not.[1]

Our aim is a straightforward one- to move the debate further away from the question of whether final good prices are flexible, towards whether cost shocks are transmitted swiftly into equivalent price rises or not. It has been shown in a variety of contexts that raw prices at the micro level are very flexible and indeed contain a significant amount of noise (see e.g. Nakamura and Steinsson (2008), Eichenbaum et al. (2011)). What is more important for macroeconomic implications is whether when costs change, prices move proportionately or not, together with the speed with which this adjustment takes place. In the context of multi-product stores, this is equivalent to seeing whether, when costs of particular goods rise or fall idiosyncratically, their prices or rather, price trends stripped of noise, also move equivalently, since the remaining costs of labour, electricity, etc., are shared amongst many products. If so, how long does it take for this movement to occur? Does this differ across products? A natural framework in which to examine this is the error correction model.

[1]See inter alia, Carlton (1986), Cecchetti (1986), Kashyap (1995), Bils and Klenow (2004), Chakraborty et al. (2015), Wulfsberg (2016), Berger and Vavra (2018) and Cavallo (2018) and the surveys by Klenow and Malin (2010), Greenslade and Parker (2012) and Nakamura and Steinsson (2013). Existing literature has focused primarily on the study of developed countries, using data from sources as diverse as store-level hand collection, mail-order catalogues, national statistical agencies, scanner data from stores, and the internet. Several contributions have considered the importance of sale prices in limiting the analyst's ability to measure correctly the extent of price dynamics, by generating errors in the measurement of the frequency of price changes; e.g. see Hendel and Nevo (2006), Nakamura (2008) and Nakamura and Steinsson (2008). These studies have also highlighted the problems that arise when trying to reconcile observed price dynamics with either flexible price models or menu costs models, as discussed in Chevalier and Kashyap (2011). In response to these concerns Kehoe and Midrigan (2008) and Eichenbaum et al. (2011) introduced modifications to the standard menu cost model to accommodate observed periods of temporary price changes, or sales.

The context of our paper is a major supermarket chain in Colombia, a country that has experienced significant periods of inflation in the past but over the period we are considering was under a strict central bank-imposed regime targeting control of inflation. Although we characterise the retailer as a supermarket, in fact the range of goods sold is extremely wide and our sample, although capturing only a small number of products, takes full advantage of this. A (probably different) supermarket chain was the target of a price-scraping exercise by Cavallo (2018). Price-scraping enables the capture of a very large number of prices but is not able to capture cost information. Indeed, studies that have been able to utilise cost information in examining price rigidity are very much in the minority. Salient exceptions are Eichenbaum et al. (2011) where an approximation to the replacement cost of an item by the retailer is constructed using data on sales and adjusted gross profit, and Anderson et al. (2017) who have data on "base wholesale costs" in their scanner-based analysis of price movements in response to cost movements, which they use to see whether prices or "regular prices" move with costs; see also Sherman and Weiss (2015). Chevalier et al. (2003) are also able to back out cost data in their study on Dominick's food stores in the US but have a different research question in mind, understanding pricing behaviour in relation to public holidays.[2]

There is a small previous literature on nominal price rigidities in Colombia. To our knowledge the first paper in this area is Jaramillo and Cerquera (1999), which provides evidence in support of the menu costs hypothesis during the years 1991-94, a period characterised by double digit inflation between about 20% and 30%. Such moderate but persistent levels of the inflation rate were prevalent in Colombia throughout the 1970s, 1980s and most of the 1990s, and as a result of that the country was branded as a "moderate-inflation country par excellence", following the terminology employed by Dornbusch and Fischer (1993). In 1991, however, a new political constitution radically modified the structure and functions of the central bank in Colombia (Banco de la República), with the purpose of creating an institution independent from the central government. The main objective of the central bank was to control inflation, and that it had to coordinate its monetary, exchange and credit policies with the macroeconomic policies implemented by the government. The official adoption of a fully-fledged inflation targeting regime only occurred several years later, in 2001. Since

[2]They do not, however, have replacement cost data, which we are able to employ in our sample. In related literature, Gopinath and Rigobon (2008), Gopinath and Itskhoki (2010) and Gopinath et al. (2010) exploit exchange rate variations to infer cost shifts.

the 1991 constitutional reform, inflation has been exhibiting a declining path to one-digit levels.[3]

In subsequent work, Julio et al. (2011) and Julio and Zárate (2011) studied nominal rigidities based on the microdata collected by the Colombian statistical agency (DANE) to construct the consumer and producer price indexes, respectively. Julio et al. (2011) find that the implicit duration of runs (or spells) of consecutive constant consumer prices amounts to approximately 8.4 months including house rental charges (6.4 months, when these are excluded), while Julio and Zárate (2011) indicate that the average duration of runs of constant producer prices is approximately 5.5 months. In both studies, the authors report a large degree of heterogeneity in their findings depending on the product under consideration. Very recently, Cavallo (2018)'s paper has also included data on Colombian prices using a scraping methodology that captures daily prices, but not costs.

Unlike this earlier literature, the distinctive aspect of our work is that we use for the first time scanner data on grocery prices and replacement costs from a major supermarket chain in Colombia. The data at our disposal are observed with daily frequency over a 2007-2010 study period. Although the sample period is not recent, a secondary benefit is that it nonetheless allows us to fill a gap in the existing literature through the examination of a developing country over a period of low and stable inflation (5.3% on average during the period under consideration). This is in marked contrast to existing studies on developing countries which have focused on episodes of high inflation; see e.g. Ahlin and Shintani (2007) and Gagnon (2009). Additionally, the fact that we use daily data rather than lower frequency data is also advantageous because the inevitable loss of information due to the use of temporal aggregation procedures does not occur in our case.

On the one hand, one would expect to observe more prevalent price rigidities in the country as a result of the dominance of cash transactions.[4] Indeed, Knotek (2011) finds evidence in support of the view that in economies where the use of cash is prevalent, prices which facilitate rapid transactions because they require few monetary units or little change in

[3]In the recent history of Colombia the lowest inflation rate was recorded in November 2013 with 1.8%. During the 2015/6 years the country witnessed a new episode of inflationary pressures, with the annual inflation rate reaching 9% in July 2016. This recent episode appears to have been short-lived, though.

[4]The dominance of cash transactions in Colombia is largely due to the size of the so-called underground (or shadow) economy. Rogoff (2002) observes that the anonymity that cash guarantees to the holder is appreciated not only by gangsters and drug dealers, but also by small businesses and entrepreneurs (and their customers) who are interested in avoiding various forms of taxation; see also Rogoff (2015). Loayza (1996) provides estimates of the size of the underground economy in Colombia of around 35% of GDP, while posterior estimates by Schneider and Hametner (2014) put this figure between 27 and 56% of GDP.

return (also known as "convenient prices"), help to generate price rigidity, as these prices are they are easier to remember. On the other hand, Colombian supermarket chains contribute to the development of new business formats by providing credit alternatives to customers for the acquisition of durable consumption goods, opening super stores and express stores in low- and middle-income cities across the Colombian territory, and fostering the marketing of their own products. The introduction of these new business practices might be expected to reduce prices through increased competition in the supermarket sector.

Most studies of supermarket pricing, such as Nakamura (2008), Kehoe and Midrigan (2008), and Eichenbaum et al. (2011), hereafter EJR, have used filtering techniques to remove what appear to be short-lived price fluctuations creating excessive noise in the data. As a preliminary analysis, in section 3 we choose to investigate prices using the approach implemented in EJR, defining a reference price (cost) as the most frequently observed (modal) price (cost) within a given time period. In our case this period is one month, given the daily frequency of our data. [5] We then proceed to our main analysis of investigating the tracking of prices to costs through the framework of an Error Correction Model (ECM).

Following our data description in section 2, and our preliminary analysis in section 3, in section 4 we use time series methods to analyse the persistence of changes in prices and costs (i.e. their long-term relationship). Section 5 concludes.

2 Data description

Our empirical analysis is based on scanner data from a major supermarket retailer in Colombia. The sample period spans 37 consecutive months between 2007 and 2010. We have observations on daily quantities and prices (net of discounts) recorded at the checkout counter of 49 stores belonging to the retailer. We also have daily information on the total cost of each specific product bought by the retailer and quantities purchased. On investigation of the cost data, it is apparent in every case that the wholesale cost of each product is a linear function of quantity purchased, with origin at zero, meaning that observed average cost is a good approximation to marginal replacement cost. The total number of time series observations for each store and product is 1,127. The information was collected directly from the supermarket retailer, and confidentiality agreements prevent us from providing any specific information that may help identify the retailer, such as the exact location of the stores or

[5] EJR have weekly data and choose the quarter as the period over which their reference prices are evaluated.

the day of the week during which price discounts are applied.[6]

We consider a total of 33 products grouped in two broadly defined categories, namely, perishable (20) and non-perishable (13). Perishable products are all fresh foods (F), while within the non-perishable category we make a further distinction among groceries (G), home (H) and other (O) products. Fresh foods include meat, poultry, fish, fruit, milk and eggs. Groceries include ambient human and pet foods. Household items include bedroom, bathroom and cooking essentials. Other items include car accessories and stationery. The choice of products in our analysis are all major selling items and include the top-selling item (by revenue) in each category of the supermarket's sales over the time period under consideration. At this point, it is worth clarifying two points related to the specific name of some of the products in the detailed tables. The first is "assisted sale" which means that the product is purchased from a counter assistant in the store as opposed to being taken from the shelves. The second is "own brand", which refers to a product that is produced/ labelled by the supermarket, as opposed to brand 1 (or 2, or 3) which indicates that the product can be found in any other supermarket chain or grocery store.[7] The total number of observations available for the empirical analysis is 1,814,470.

Although a wider selection of products (94) and a larger number of stores (67) were available for the analysis in the original database, some of these products (such as some brands of motorcycles, televisions and laptop computers) had to be excluded because of the low number of sales in individual stores. As for the selected stores, they represent all those operated by the supermarket chain in Colombia, with the exception of outlets that had been opened for less than a year.[8] In sum, we end up analysing the dynamics of prices and costs of 33 products for 49 stores owned by the supermarket chain and located across the Colombian territory.

In Appendix A, we investigate the price behaviour of the same set of 33 products in the 13 main shops of the supermarket in the capital Bogotá, then contrast these with the remaining stores outside Bogotá in Appendix B. The idea behind this exercise is to investigate the

[6]Given the confidentiality agreements, to avoid disclosure of the store chain's name through its precise discount policy related to a day of the week, for purposes of replication we have masked the database by dropping five observations from each product and store, and deliberately modifying the start of the study period to July 1, 2007. The results based on the masked version of the database are very similar to the ones reported in the paper. The masked data file and replication script (designed for Stata 14) are available from the authors upon request.

[7]Brand names have been disguised.

[8]These latter shops would provide only a few observations for the analysis and the sales patterns might have been affected by the novelty of having a new store in a particular area.

possibility that more intense competition with other supermarket chains within the capital city might affect price dynamics more effectively than in less densely populated areas around the country, where price competition can be weaker. For example one might expect that, as a result of competition, mark-ups of prices over costs may be smaller, or prices may adjust more rapidly when mark-ups are above or below their long-term equilibrium level (see Sherman and Weiss (2015)). When focussing on the stores in Bogotá the number of observations is 480,102, that is about one quarter of the total number of observations available for the country as a whole.

The price information used in the paper is based on scanner data recorded at the checkout counter that day. Therefore we avoid the measurement errors in some other papers, e.g. EJR's, faced due to their calculating prices as the ratio of sales value to quantities sold, and hence include the effect of discounts associated with loyalty cards, coupons and promotions.[9] If a product is not sold on a particular day, we set the associated price and cost equal to the values observed in the previous day.

In addition to the more reliable information about the prices actually displayed in the supermarket, the advantage of our dataset, compared to that used in EJR and other studies, is the high frequency of observations for prices and costs which allows us to evaluate the price dynamics (or possibly their inertia) more precisely. Inevitably though, our sample frame limits our ability to generalise our results to a wider range of goods and to other supermarket chains. In effect, we treat price-setting as a response to the general competitive framework rather than specific moves by other firms.

Figures 1 to 3 show the time path of prices and costs for all 33 products averaged across stores. Casual visual inspection of these plots reveals that prices tend to exhibit significantly greater variability/ noise over time than costs, although there are both perishable and non-perishable products (such as chicken breast, eggs, lactose-free milk branded 3, roast chicken branded, dog food own brand, pillows branded 1 (ref. 65X45) and tyres) whose prices remain constant over extended periods of time. It is also possible to observe that for some of the products in the categories of fresh foods and groceries price discounts occur very frequently, and that in some instances their magnitude may be such that prices fall even below costs. Costs, on the other hand, exhibit a greater degree of constancy over time.

[9]Eichenbaum et al. (2014) observe that generating prices in this way can create spurious small changes in prices.

3 Initial empirical analysis

To gain a sense of underlying trends, we first examine reference prices (as in EJR) and reference costs as the most frequently observed values within a month. In order to avoid recording unusual observations as a result of the cut-off points chosen for the start and end of the month, we carried out an additional exercise which involved calculating reference prices as the modal price using a moving window of 7 days over a period of 28 days, and similarly for reference costs. This can be viewed as a robustness check to assess the potential effect on our results of special discounts associated with specific holidays and subsequent price adjustments in the following periods. Although the results obtained using this second approach suggest (perhaps not surprisingly) that reference prices and reference costs are slightly less persistent, all other findings are qualitatively similar to those obtained using the actual calendar dates as cut off points for individual months, confirming that our results are robust to the choice of start and end points for a monthly period. In what follows, we present the results based on the first approach.

Table 1 shows that actual prices spend 77% of the time on average at the same level as the reference price, while according to the same table the corresponding value for costs is 92%. Interestingly, the information contained in these two tables exhibits a large degree of heterogeneity across different products, which we believe is related to their perishability. Looking at specific products we find that the prices and costs of perishable goods, such as meats, tend to spend a lower proportion of time at the same level as reference price.

Regarding price and cost variations through time, Table 2 indicates that the fraction of months in which daily prices are constant for the whole month is 29%, compared to 73% for costs. The distinction between perishable and more durable goods is also present when one considers the proportion of time when prices and costs are constant for the whole month. While the prices of perishable goods remain (on average) constant about 27% of the time, those of non-perishable goods remain constant about 31% of the time. On the other hand costs are a lot more persistent across all groups of products, with the notable exception of papaya melona and mojarra fish, with percentages below 26%.

Table 3 shows that actual prices change 15% of the time when costs do not change, while the probability of reference prices changing when reference costs do not change is miniscule. Table 4 describes in more detail the analysis of the movements from non-reference (NR) to reference (R) price and vice versa, and similarly for cost movements. According to the

results, perishable goods tend to remain at reference price for approximately 89% of the period, while the highest incidence of persistence at reference prices is again observed for non-perishable goods, which tend to remain at reference price for about 94%. On the other hand reference costs for all products tend to remain in that status (on average) for 99% of the time. The products whose cost remain most persistently at reference level are non-perishable goods, such as pillows, towels and tyres. We also find a difference between perishable and non-perishable goods in their movements from non-reference to reference price, which are observed on average 30% and 23% of the time, respectively. Two interesting cases where such movement takes place in a considerable manner are chicken breast and thin steak (on average 45% of the time), both of which are perishable products.

It is clear from the data in Table 5 that markups, calculated using actual prices and actual costs, vary widely across products, as expected. The results of our analysis of the daily actual mark-ups as calculated for the products sold in Bogotá are reported in Table A.5. They reveal an average mark-up for daily prices of 28%, with a lowest mark-up on eggs (1%) and the highest of 71% for branded pillows. Perishable goods in general seem to have rather low markups averaging approximately 22% compared to all other products, and particularly compared with other non-perishable goods, such as home and other products, which attract mark-ups of between 29% and 71%.

4 Analysis of price persistence

We now turn to the analysis of price and cost persistence for the supermarket stores in Colombia and in Bogotá. Results not reported here (to save space) indicate that, as would be expected, in the whole country the probability of a daily price change is much higher (0.157) than the probability of a change in reference price (0.011), that is a factor of approximately fifteen times on average. For the supermarkets in the Bogotá area the difference in these two probabilities also involves a factor of similar magnitude. Using the probability of a price change for the whole country using daily data, we find in Table 6 that the implied duration of price stability is approximately 6.4 days, which corresponds to approximately one week, as opposed to about two weeks in EJR. Reference prices on the other hand are stable for nearly a year in EJR compared to only about three months in our study (that is, 91.2 days). For the supermarkets in Bogotá (Table A.6) the implied persistence of price and reference price is somewhat smaller, namely 5.7 and 82.7 days, respectively. As for costs, we find

that the probability of a daily cost change is higher than that of a change in reference cost, both in the whole of the country (2% against 0.7%) and in Bogotá (2.5% against 0.8%). Interestingly, significant variations in persistence can be observed among products, with the highest duration in reference costs being for lactose free milk branded 3, both in the whole country (essentially the whole of our period) and in Bogotá. Other products whose implied duration of reference costs exceeds a year across the country are chicken breast, pillows and towels; see Table 6.

Because our data set has the advantage of a large number of daily observations ($T = 1127$), we are able to assess price persistence interpreted here as the way in which prices adjust after deviations (whether positive or negative) from the long term level of the mark up of prices over costs using standard statistical techniques. We go on to evaluate whether daily prices react differently to positive and negative deviations from the long term relationship between prices and costs. We aim to identify whether there is a long term relationship between price and cost as an equilibrium mark-up for each particular product, and then assess the extent to which prices adjust in response to deviations from this long term (or steady state) relationship. We also investigate whether such response is asymmetric, depending on whether a positive or a negative deviation from the long term mark-up is observed.

Our econometric analysis of this type of state dependence involves the estimation of an error correction model for the price variations of each product:

$$\Delta p_t = \alpha + \sum_{k=1}^{m} \beta_k \Delta p_{t-k} + \sum_{k=0}^{n} \gamma_k \Delta c_{t-k} + \delta ect_{t-1} + u_t, \tag{1}$$

where Δ is the first difference operator; p_t is price at time t; c_t is cost, also at time t, which is assumed to be weakly exogenous; $ect_{t-1} \equiv p_{t-1} - c_{t-1}$ (for error correction term) is the mark up of prices over costs lagged one period; m and n are respectively the number of lags of Δp_t and Δc_t, and u_t is the error term.[10] In Eq. (1) there are five cases of interest depending on the value taken by δ. First, if $-1 < \delta < 0$ then there is an error correction mechanism linking p_t and c_t whereas second, if $\delta = 0$ there is no error correction mechanism and third, if $\delta = -1$ then all the required adjustment in prices occurs in 1 period. Fourth, if $\delta < -1$ then there is overshooting, and adjustment occurs in an oscillatory manner. Fifth,

[10] Although one might be tempted to assess price persistence through the use of established time series methodologies (for instance, by taking advantage of some of the unit root and cointegration tests available in the literature), we refrain from doing so because there are frequent (and sometimes prolonged) periods of time when our individual price and cost data are constant (or exhibit little variation). Therefore, such approaches would not shed additional light on the relationships of interest.

if $\delta > 0$ then the disequilibrium expands. Lastly, also of interest is the aspect related to the dynamics of the adjustment of prices to costs and the mark-up. For this, the coefficient δ provides a measure of the speed of adjustment of Δp_t to a shock through the concept of half life, that is the amount of time required for the effects of a shock to dissipate to one-half, which is approximately $\text{hlife} = -\ln(2)/\ln(1+\hat{\delta})$. For our purposes the half life of a shock is measured in days.

Extending the model in Eq. (1) further, we estimate an error correction model where the coefficients associated with deviations from the long term relationship between prices and costs are allowed to differ depending on whether the such deviations are positive or negative (i.e mark-ups in excess or below of the long term level). One view, supported by the empirical and theoretical "Rockets and Feathers" literature (Bacon (1991), Tappata (2009)), is that more substantial and rapid adjustments for negative than for positive deviations will be made, since the former are associated with lower than 'normal' levels of profitability, but clearly this depends on the state of competition and has not been found universally true. To examine the possibility of asymmetric adjustment, Granger and Lee (1989) generalise the standard error correction mechanism by partitioning the error correction term into its positive and negative components about its mean value, and feed them back into the short-run dynamic equation. Using our notation, this implies defining the terms $ect_{t-1}^{(+)} = \max(ect_{t-1}, 0)$ and $ect_{t-1}^{(-)} = \min(ect_{t-1}, 0)$, where $ect_{t-1} = ect_{t-1}^{(+)} + ect_{t-1}^{(-)}$, so that the error correction model in Eq. (1) becomes:

$$\Delta p_t = \alpha + \sum_{k=1}^{m} \beta_k \Delta p_{t-k} + \sum_{k=0}^{n} \gamma_k \Delta c_{t-k} + \delta^{+} ect_{t-1}^{+} + \delta^{-} ect_{t-1}^{-} + u_t, \tag{2}$$

The coefficients on the partitioned error correction terms $ect_{t-1}^{(+)}$ and $ect_{t-1}^{(-)}$ reflect the speed of adjustment on either side of the attractor. Therefore, if the estimated coefficients turn out to be significantly different from each other, then the null hypothesis of symmetry (H0: $\delta^{+} = \delta^{-}$) is rejected against the alternative of asymmetry (Ha: $\delta^{+} \neq \delta^{-}$). In the case of asymmetry, we can estimate the half life of a shock for positive and negative deviations from equilibrium, i.e. approximately $\text{hlife}^{+} = -\ln(2)/\ln(1+\hat{\delta}^{+})$ and $\text{hlife}^{-} = -\ln(2)/\ln(1+\hat{\delta}^{-})$, respectively.

Following the modelling approach outlined above, we proceed to test for the existence of an error correction type of mechanism involving prices and costs, where both variables are measured in logarithms. Thus, for each product the underlying models in Eqs. (1) and (2)

are estimated by ordinary least squares (OLS) for up to $m = n = 7$ lags (that is, a week), with the appropriate lag length determined using the Schwarz information criterion (SIC); qualitatively similar findings are obtained when the optimal lag lengths are selected using the Akaike information criterion (AIC), though. To ensure comparability of the models for different choices of m and n, all estimations are carried out over the same sample period. Hence, our approach is quite general in the sense that we allow for differential lag lengths on the lagged variables Δp_{t-k} and Δc_{t-k} in Eqs. (1) and (2).[11]

OLS estimates of the symmetric and asymmetric versions of the error correction models for each product are summarised in Tables 7 for Colombia, and A.7 for Bogotá. The symmetric models show that the estimated coefficients on the lagged error correction term (ect_{t-1}) all have the expected negative sign and are statistically significant at least at the 5% level based on a one-sided t-test. This suggests that price adjustments for all products work in the opposite direction to the imbalance between prices and costs, in order to induce a return to the long term mark-up level. The information contained in the right-hand side of Tables 7 and A.7 can be subsequently used to test the null hypothesis of symmetry, i.e. $\delta^+ = \delta^-$, against the alternative of asymmetry, i.e. $\delta^+ \neq \delta^-$. The results are presented in columns 2 and 3 of Table 8 for the whole country, and Table A.8 for the capital. Using a 5% significance level, our findings indicate the presence of asymmetry in 11 out of 33 products for Colombia, with a few more cases (15 out of 33) for Bogotá. The range of products that supports the presence of asymmetric behaviour includes mostly perishable items, and to a lesser extent non-perishable ones. In terms of the speed of adjustment, it is possible to observe that in the symmetric models for Colombia there is substantial heterogeneity, with estimates of the half life ranging from 2 days (papaya melona) to 95 days (chicken breast own brand), which is rather an outlier. It is noteworthy that in the symmetric models for Bogotá the range of variation of the half life is much narrower, from 2 days (chicken breast) to 27 days (towels), possibly reflecting more intense competition from other supermarket chains in the capital than in the other parts of the country.

Turning to the asymmetric models for all stores in the country (Table 8), beef steak and bedspreads exhibit differentiated speed of adjustment depending on whether the mark-up is above or below its long-term equilibrium level. In the case of beef steak we observe the

[11] We also experimented with longer lag structures, for example by setting $m = n = 30$ lags (that is, a month), and the results were largely the same, except that (not surprisingly) in some cases we observed slightly larger standard errors due to multicollinearity among the explanatory variables.

result that hlife$^+$ > hlife$^-$, which supports the view that the speed of adjustment of prices is much slower when the mark-up is above equilibrium than when it is below; similar behaviour is also observed for beef products in the Bogotá stores (Table A.8) and it is notable that several more of the Bogotá products exhibit asymmetry than do those outside Bogotá (Table B.2). In the case of bedspreads we observe that price adjustment is quicker in the presence of positive deviations from the long-term mark-up, i.e. hlife$^+$ < hlife$^-$, possibly because this product is used as a loss leader in order to attract customers to the supermarket. In other words, it may be the case that a bedspread exemplifies a product where prices unusually above their long-term mark-up level might lead to potential losses in other more profitable departments. Lastly, it can also be seen that there are several instances where the half life for positive deviations from the mark-up equilibrium level cannot be computed because the estimate of δ^+ lies outside the (0,-1) interval. Although this finding suggests surprisingly that Δp_t does not seem to be moving in the "right" direction when $ect_{t-1} > 0$, that is, instead of moving downwards it is either moving upwards or not moving at all, when $ect_{t-1} < 0$ the error correction mechanism appears to be working via the expected movement of Δp_t.

5 Concluding remarks

This paper investigated the extent of price inertia in retail grocery prices and costs using a detailed dataset for a large supermarket chain in Colombia using daily data over a 2007-2010 study period. Compared to other work in this area our dataset has the advantage of offering a large number of daily observations, although the number of products with sufficiently numerous observations is more limited than in many other studies. We analysed 33 products sold in 49 stores in the whole of Colombia, but also contrasted cost and price behaviour in the capital city of Bogotá, where one would expect to observe more intense competition among supermarkets, compared with that in the remainder of the country.

Our main focus is on using error correction models to investigate the sign and size of price adjustments which occur in response to deviations from the long term relationships between prices and costs. Our results reveal in most cases a negative adjustment to such deviations, indicative of reversion to the long term level of mark-ups. They contribute to the literature on nominal rigidities, defined as inertia in reference prices and costs, by providing microeconomic evidence about the extent of such inertia in the grocery retail sector, and about the nature of the price adjustments triggered by deviations from long term equilibrium

levels for the mark-ups of prices over costs.

What are the wider implications of our results? To put them in context, they come from a country that, at the time, was experiencing a period of stability, with low inflation. On the one hand, price movements follow cost movements relatively closely, with variable lags but without much delay, which suggests that shocks to the economy would be played out fairly rapidly. However, there are significant timing differences across products, and there are some with substantial half-lives on prices, which temper that conclusion. Also, competition matters- the more intense competition in Bogotá compared with the remainder of the country gives rise to swifter reactions to cost shocks. Moreover, and we think a rather novel finding, the speed with which which prices follow costs differs significantly depending on whether costs are rising or falling, for a significant proportion of products. It would be interesting to see whether this finding is unusual to this supermarket and country, or whether, as the sporadic findings of the "rockets and feathers" literature suggest, it could be more general. If so, there would be important implications for macroeconomic modelling.

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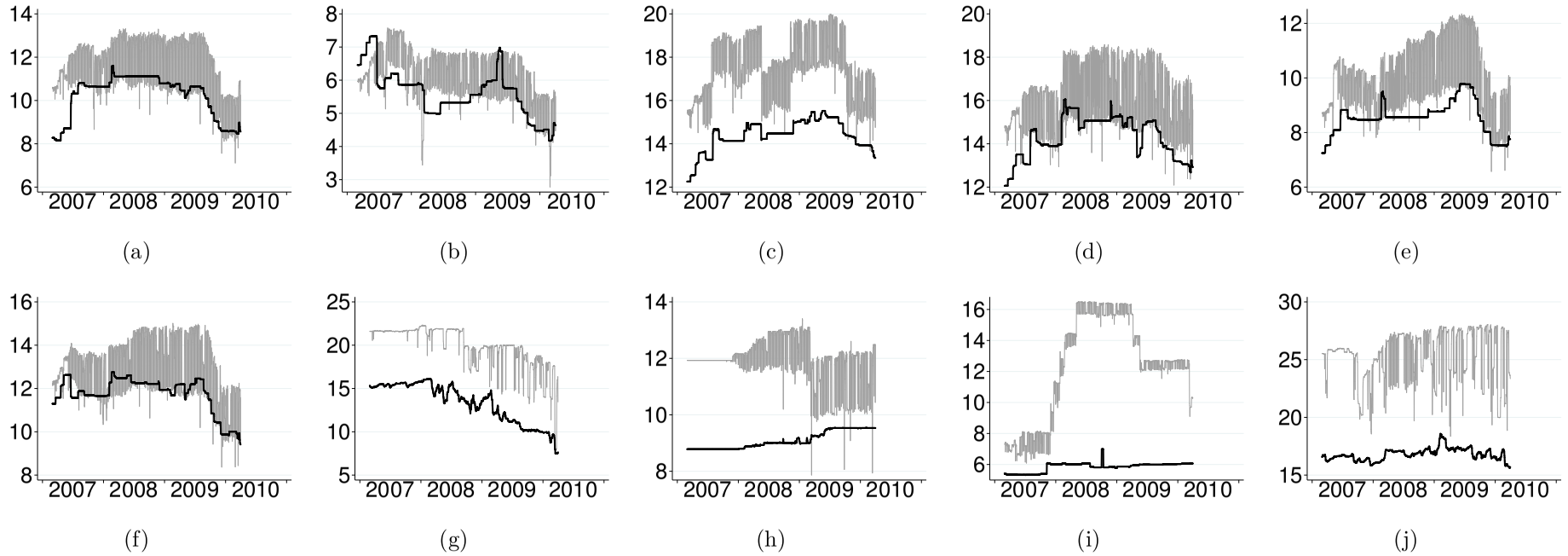
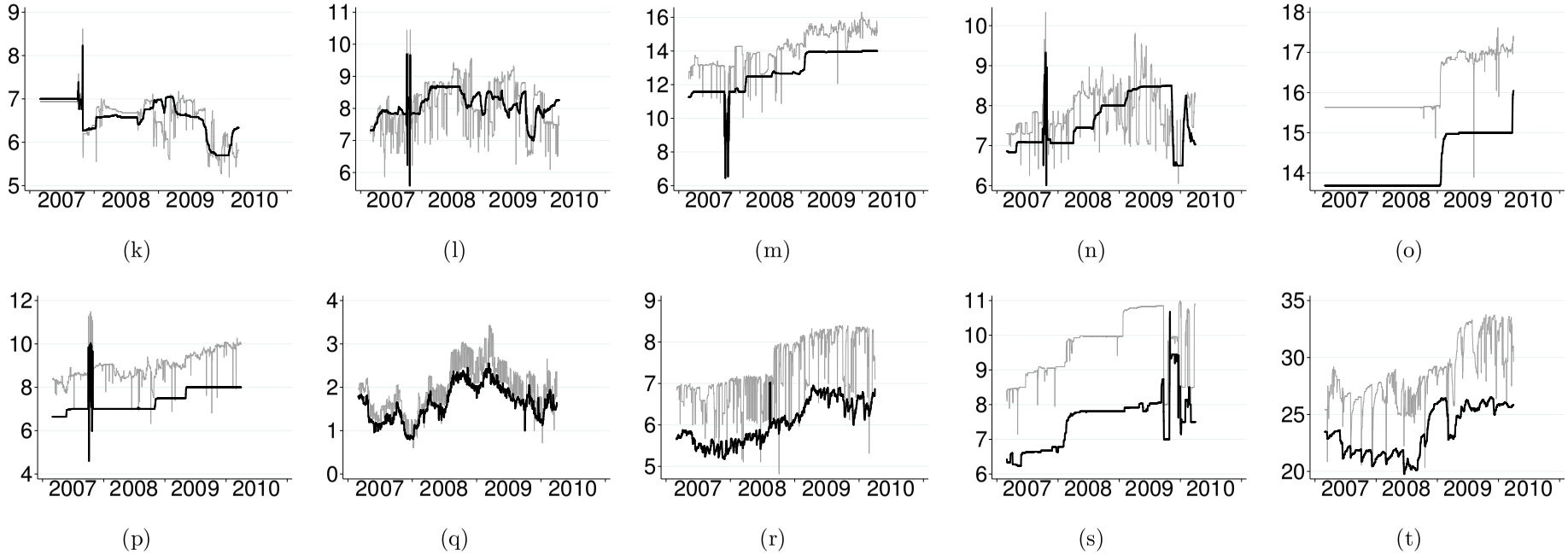
Figure 1: Prices (grey line) and costs (black line) of fresh food products. Thousands of pesos



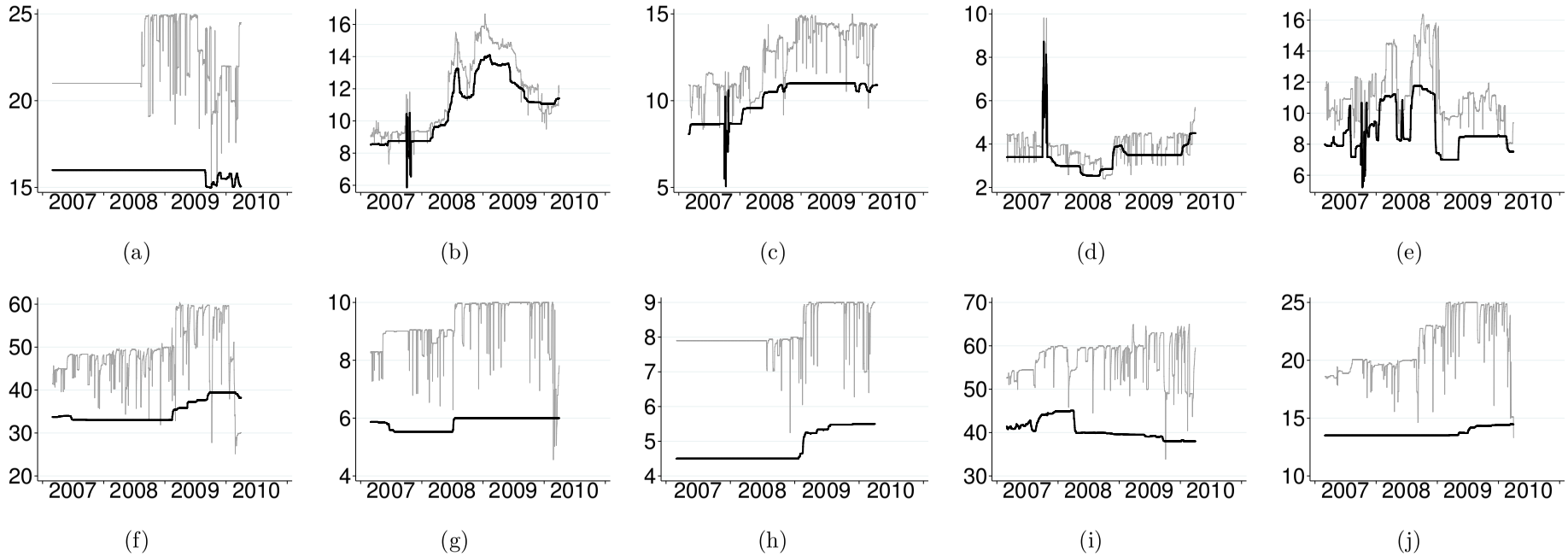
Note: (a) Beef (minute steak); (b) Beef (ribs); (c) Beef (rump steak assisted sale); (d) Beef (rump steak); (e) Beef (sirloin); (f) Beef (thick flank); (g) Catfish fillets (imported); (h) Chicken breast; (i) Chicken breast with skin own brand; (j) Cooked prawn assisted sale.

Figure 1: *Continued from previous page*



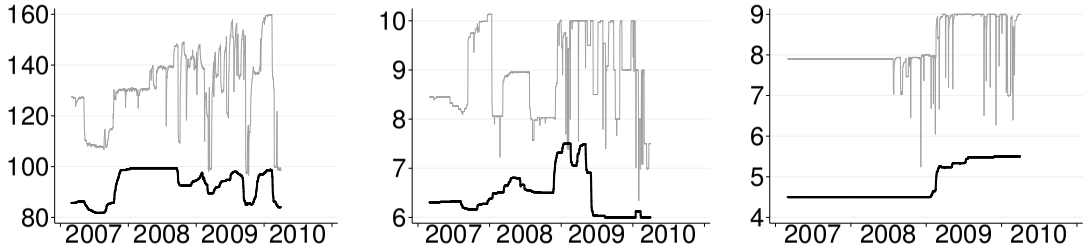
Note: (k) Eggs 30 units red branded 1; (l) Full fat milk own brand (6X900ml); (m) Lactose-free milk branded 1 (6X1100ml); (n) Lactose-free milk branded 2 UHT (4X946ml); (o) Lactose-free milk branded 3 (6X1300ml); (p) Packet of sausages 500gr branded; (q) Papaya melona; (r) Red mojarra fish; (s) Roast chicken branded; (t) Salmon fillets.

Figure 2: Prices (grey line) and costs (black line) of groceries and household products. Thousands of pesos



Note: (a) Dog food own brand; (b) Rice 5kg branded; (c) Soya oil X 3000cm3 own brand; (d) Sugar 2.5kg own brand; (e) Toilet paper 12 rolls own brand; (f) Bedspread; (g) Pillow branded 1 50X70; (h) Pillow branded 1 65X45; (i) Pressure cooker 6lt branded; (j) Set of two towels branded.

Figure 3: Prices (grey line) and costs (black line) of other products. Thousands of pesos



(a) (b) (c)

Note: (a) Car battery own brand; (b) Printer paper 75gr; (c) Tyres R13.

Table 1: Fraction of days price (cost) spent at, below or above reference price (cost)

Product	Same		Below		Above	
	p	c	p	c	p	c
All products	0.77	0.92	0.16	0.04	0.07	0.04
(F) Beef (minute steak)	0.70	0.92	0.26	0.04	0.04	0.04
(F) Beef (ribs)	0.66	0.91	0.27	0.06	0.07	0.03
(F) Beef (rump steak assisted sale)	0.77	0.92	0.17	0.04	0.06	0.03
(F) Beef (rump steak)	0.62	0.89	0.31	0.06	0.07	0.05
(F) Beef (sirloin)	0.66	0.91	0.28	0.04	0.06	0.05
(F) Beef (thick flank)	0.66	0.91	0.26	0.04	0.08	0.05
(F) Catfish fillets (imported)	0.81	0.85	0.14	0.07	0.05	0.08
(F) Chicken breast	0.85	0.98	0.13	0.01	0.02	0.01
(F) Chicken breast with skin own brand	0.83	0.98	0.13	0.02	0.04	0.00
(F) Cooked prawn assisted sale	0.70	0.82	0.22	0.10	0.08	0.08
(F) Eggs 30 units red branded 1	0.88	0.96	0.08	0.03	0.05	0.02
(F) Full fat milk own brand (6X900ml)	0.69	0.87	0.20	0.07	0.11	0.06
(F) Lactose-free milk branded 1 (6X1100ml)	0.76	0.96	0.15	0.02	0.09	0.02
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.75	0.95	0.11	0.03	0.13	0.03
(F) Lactose-free milk branded 3 (6X1300ml)	0.94	0.99	0.03	0.00	0.03	0.01
(F) Packet of sausages 500gr branded	0.75	0.97	0.15	0.01	0.10	0.01
(F) Papaya melona	0.66	0.76	0.22	0.14	0.13	0.10
(F) Red mojarra fish	0.75	0.77	0.20	0.13	0.05	0.10
(F) Roast chicken branded	0.92	0.94	0.03	0.04	0.05	0.03
(F) Salmon fillets	0.77	0.83	0.16	0.09	0.07	0.08
(G) Dog food own brand	0.83	0.97	0.12	0.01	0.05	0.02
(G) Rice 5kg branded	0.72	0.92	0.15	0.04	0.14	0.04
(G) Soya oil X 3000cm3 own brand	0.65	0.91	0.24	0.05	0.11	0.03
(G) Sugar 2.5kg own brand	0.72	0.94	0.17	0.03	0.11	0.03
(G) Toilet paper 12 rolls own brand	0.65	0.91	0.17	0.04	0.17	0.05
(H) Bedspread	0.80	0.96	0.17	0.03	0.03	0.01
(H) Pillow branded 1 50X70	0.89	0.99	0.09	0.01	0.02	0.00
(H) Pillow branded 1 65X45	0.94	0.99	0.05	0.00	0.01	0.01
(H) Pressure cooker 6lt branded	0.83	0.95	0.10	0.03	0.07	0.03
(H) Set of two towels branded	0.89	0.99	0.09	0.01	0.03	0.00
(O) Car battery own brand	0.71	0.93	0.21	0.04	0.08	0.03
(O) Printer paper 75gr	0.82	0.96	0.10	0.02	0.07	0.02
(O) Tyres R13	0.81	0.94	0.12	0.03	0.07	0.03

Note: Henceforth, (F), (G), (H) and (O) denote fresh foods, groceries, household items, and other, respectively. All products have between 51,842 and 55,223 observations giving a total of 1,814,470.

Table 2: Fraction of months in which daily prices (costs) are constant for the whole month

Product	Price	Cost
All products	0.29	0.73
(F) Beef (minute steak)	0.10	0.68
(F) Beef (ribs)	0.09	0.68
(F) Beef (rump steak assisted sale)	0.43	0.73
(F) Beef (rump steak)	0.10	0.59
(F) Beef (sirloin)	0.09	0.65
(F) Beef (thick flank)	0.10	0.67
(F) Catfish fillets (imported)	0.24	0.52
(F) Chicken breast	0.48	0.92
(F) Chicken breast with skin own brand	0.48	0.91
(F) Cooked prawn assisted sale	0.15	0.41
(F) Eggs 30 units red branded 1	0.59	0.82
(F) Full fat milk own brand (6X900ml)	0.19	0.57
(F) Lactose-free milk branded 1 (6X1100ml)	0.19	0.87
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.21	0.81
(F) Lactose-free milk branded 3 (6X1300ml)	0.76	0.96
(F) Packet of sausages 500gr branded	0.13	0.90
(F) Papaya melona	0.10	0.19
(F) Red mojarra fish	0.12	0.25
(F) Roast chicken branded	0.63	0.74
(F) Salmon fillets	0.29	0.45
(G) Dog food own brand	0.48	0.86
(G) Rice 5kg branded	0.24	0.73
(G) Soya oil X 3000cm3 own brand	0.12	0.75
(G) Sugar 2.5kg own brand	0.19	0.81
(G) Toilet paper 12 rolls own brand	0.16	0.66
(H) Bedspread	0.21	0.89
(H) Pillow branded 1 50X70	0.33	0.96
(H) Pillow branded 1 65X45	0.60	0.97
(H) Pressure cooker 6lt branded	0.32	0.78
(H) Set of two towels branded	0.44	0.97
(O) Car battery own brand	0.21	0.72
(O) Printer paper 75gr	0.40	0.82
(O) Tyres R13	0.35	0.81

Note: All products have between 51,796 and 55,174 observations giving a total of 1,812,860.

Table 3: Prob. of price (reference price) changing when cost (reference cost) does not change

Product	Price	Reference price
All products	0.15	0.01
(F) Beef (minute steak)	0.30	0.01
(F) Beef (ribs)	0.29	0.01
(F) Beef (rump steak assisted sale)	0.19	0.01
(F) Beef (rump steak)	0.34	0.01
(F) Beef (sirloin)	0.32	0.01
(F) Beef (thick flank)	0.30	0.01
(F) Catfish fillets (imported)	0.12	0.00
(F) Chicken breast	0.15	0.00
(F) Chicken breast with skin own brand	0.15	0.01
(F) Cooked prawn assisted sale	0.19	0.01
(F) Eggs 30 units red branded 1	0.06	0.00
(F) Full fat milk own brand (6X900ml)	0.17	0.01
(F) Lactose-free milk branded 1 (6X1100ml)	0.11	0.01
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.11	0.01
(F) Lactose-free milk branded 3 (6X1300ml)	0.02	0.00
(F) Packet of sausages 500gr branded	0.13	0.01
(F) Papaya melona	0.22	0.01
(F) Red mojarra fish	0.13	0.00
(F) Roast chicken branded	0.02	0.00
(F) Salmon fillets	0.10	0.00
(G) Dog food own brand	0.13	0.01
(G) Rice 5kg branded	0.11	0.01
(G) Soya oil X 3000cm3 own brand	0.27	0.01
(G) Sugar 2.5kg own brand	0.14	0.01
(G) Toilet paper 12 rolls own brand	0.20	0.01
(H) Bedspread	0.10	0.01
(H) Pillow branded 1 50X70	0.08	0.01
(H) Pillow branded 1 65X45	0.04	0.00
(H) Pressure cooker 6lt branded	0.07	0.01
(H) Set of two towels branded	0.06	0.00
(O) Car battery own brand	0.13	0.01
(O) Printer paper 75gr	0.07	0.01
(O) Tyres R13	0.07	0.01

Note: All products have between 51,796 and 55,174 observations giving a total of 1,812,860.

Table 4: Transition matrices for prices (p) and costs (c)

Product	NR to NR		NR to R		R to NR		R to R	
	p	c	p	c	p	c	p	c
All products	0.73	0.85	0.27	0.15	0.08	0.01	0.92	0.99
(F) Beef (minute steak)	0.55	0.89	0.45	0.11	0.19	0.01	0.81	0.99
(F) Beef (ribs)	0.65	0.89	0.35	0.11	0.18	0.01	0.82	0.99
(F) Beef (rump steak assisted sale)	0.66	0.89	0.34	0.11	0.10	0.01	0.90	0.99
(F) Beef (rump steak)	0.65	0.88	0.35	0.12	0.21	0.02	0.79	0.99
(F) Beef (sirloin)	0.62	0.89	0.38	0.11	0.20	0.01	0.80	0.99
(F) Beef (thick flank)	0.63	0.88	0.37	0.12	0.19	0.01	0.81	0.99
(F) Catfish fillets (imported)	0.70	0.87	0.30	0.13	0.07	0.02	0.93	0.98
(F) Chicken breast	0.55	0.83	0.45	0.17	0.08	0.00	0.92	1.00
(F) Chicken breast with skin own brand	0.62	0.86	0.38	0.14	0.08	0.00	0.92	1.00
(F) Cooked prawn assisted sale	0.74	0.86	0.26	0.14	0.11	0.03	0.89	0.97
(F) Eggs 30 units red branded 1	0.77	0.87	0.23	0.13	0.03	0.01	0.97	0.99
(F) Full fat milk own brand (6X900ml)	0.77	0.82	0.23	0.18	0.10	0.03	0.90	0.97
(F) Lactose-free milk branded 1 (6X1100ml)	0.79	0.81	0.21	0.19	0.06	0.01	0.94	0.99
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.81	0.86	0.19	0.14	0.06	0.01	0.94	0.99
(F) Lactose-free milk branded 3 (6X1300ml)	0.80	0.92	0.20	0.08	0.01	0.00	0.99	1.00
(F) Packet of sausages 500gr branded	0.76	0.77	0.24	0.23	0.08	0.01	0.92	0.99
(F) Papaya melona	0.66	0.73	0.34	0.27	0.18	0.08	0.82	0.92
(F) Red mojarra fish	0.74	0.82	0.26	0.18	0.09	0.05	0.91	0.95
(F) Roast chicken branded	0.81	0.86	0.19	0.14	0.02	0.01	0.98	0.99
(F) Salmon fillets	0.81	0.89	0.19	0.11	0.06	0.02	0.94	0.98
(G) Dog food own brand	0.76	0.87	0.24	0.13	0.05	0.00	0.95	1.00
(G) Rice 5kg branded	0.84	0.87	0.16	0.13	0.06	0.01	0.94	0.99
(G) Soya oil X 3000cm3 own brand	0.69	0.88	0.31	0.12	0.17	0.01	0.83	0.99
(G) Sugar 2.5kg own brand	0.78	0.84	0.22	0.16	0.09	0.01	0.92	0.99
(G) Toilet paper 12 rolls own brand	0.79	0.86	0.21	0.15	0.11	0.01	0.89	0.99
(H) Bedspread	0.79	0.91	0.21	0.09	0.05	0.00	0.95	1.00
(H) Pillow branded 1 50X70	0.68	0.88	0.32	0.12	0.04	0.00	0.96	1.00
(H) Pillow branded 1 65X45	0.66	0.88	0.34	0.12	0.02	0.00	0.98	1.00
(H) Pressure cooker 6lt branded	0.82	0.88	0.18	0.12	0.04	0.01	0.96	0.99
(H) Set of two towels branded	0.76	0.88	0.24	0.12	0.03	0.00	0.97	1.00
(O) Car battery own brand	0.84	0.87	0.16	0.13	0.07	0.01	0.93	0.99
(O) Printer paper 75gr	0.83	0.86	0.17	0.14	0.04	0.01	0.96	0.99
(O) Tyres R13	0.84	0.90	0.16	0.10	0.04	0.01	0.96	0.99

Note: NR and R denote non-reference and reference, respectively. All products have between 51,796 and 55,174 observations giving a total of 1,812,860.

Table 5: Mean and standard deviation of actual and reference daily markups

Product	Actual		Reference	
	Mean	s.d.	Mean	s.d.
All products	0.30	0.68	0.32	0.68
(F) Beef (minute steak)	0.17	0.16	0.22	0.14
(F) Beef (ribs)	0.14	0.21	0.19	0.19
(F) Beef (rump steak assisted sale)	0.24	0.65	0.27	0.65
(F) Beef (rump steak)	0.16	0.17	0.21	0.15
(F) Beef (sirloin)	0.20	0.15	0.26	0.13
(F) Beef (thick flank)	0.13	0.32	0.18	0.31
(F) Catfish fillets (imported)	0.54	0.29	0.58	0.29
(F) Chicken breast	0.32	1.09	0.34	1.09
(F) Chicken breast with skin own brand	1.15	3.45	1.17	3.42
(F) Cooked prawn assisted sale	0.52	0.20	0.56	0.19
(F) Eggs 30 units red branded 1	0.00	0.14	0.00	0.13
(F) Full fat milk own brand (6X900ml)	0.00	0.13	0.02	0.12
(F) Lactose-free milk branded 1 (6X1100ml)	0.11	0.08	0.12	0.10
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.03	0.12	0.03	0.12
(F) Lactose-free milk branded 3 (6X1300ml)	0.14	0.03	0.14	0.03
(F) Packet of sausages 500gr branded	0.22	0.09	0.23	0.09
(F) Papaya melona	0.26	0.35	0.27	0.31
(F) Red mojarra fish	0.21	0.14	0.24	0.13
(F) Roast chicken branded	0.30	0.14	0.30	0.14
(F) Salmon fillets	0.23	0.18	0.24	0.18
(G) Dog food own brand	0.39	0.14	0.40	0.14
(G) Rice 5kg branded	0.08	0.14	0.08	0.14
(G) Soya oil X 3000cm3 own brand	0.24	0.13	0.26	0.12
(G) Sugar 2.5kg own brand	0.16	0.18	0.18	0.19
(G) Toilet paper 12 rolls own brand	0.28	0.23	0.28	0.21
(H) Bedspread	0.40	0.22	0.45	0.19
(H) Pillow branded 1 50X70	0.59	0.16	0.61	0.13
(H) Pillow branded 1 65X45	0.71	0.13	0.72	0.11
(H) Pressure cooker 6lt branded	0.42	0.16	0.42	0.15
(H) Set of two towels branded	0.56	0.21	0.58	0.20
(O) Car battery own brand	0.41	0.16	0.44	0.17
(O) Printer paper 75gr	0.38	0.17	0.39	0.16
(O) Tyres R13	0.29	0.12	0.29	0.12

Note: All products have between 51,842 and 55,223 observations giving a total of 1,814,470.

Table 6: Implied duration of actual and reference price and cost changes

Product	Actual		Reference	
	p	c	p	c
All products	6.4	50.0	91.2	141.5
(F) Beef (minute steak)	3.3	82.7	86.5	113.8
(F) Beef (ribs)	3.4	90.2	85.3	106.5
(F) Beef (rump steak assisted sale)	5.0	82.0	99.3	130.0
(F) Beef (rump steak)	2.9	55.7	73.1	84.8
(F) Beef (sirloin)	3.1	79.3	70.8	109.0
(F) Beef (thick flank)	3.3	77.3	75.0	94.0
(F) Catfish fillets (imported)	8.0	30.9	156.3	90.4
(F) Chicken breast	6.5	231.0	204.0	614.2
(F) Chicken breast with skin own brand	6.5	264.3	162.4	523.2
(F) Cooked prawn assisted sale	4.9	20.6	98.3	71.0
(F) Eggs 30 units red branded 1	14.9	122.0	115.5	188.3
(F) Full fat milk own brand (6X900ml)	5.2	21.9	70.0	89.9
(F) Lactose-free milk branded 1 (6X1100ml)	7.9	54.3	79.6	219.8
(F) Lactose-free milk branded 2 UHT (4X946ml)	8.6	75.4	59.1	170.3
(F) Lactose-free milk branded 3 (6X1300ml)	40.0	716.5	308.2	1,283.0
(F) Packet of sausages 500gr branded	6.8	62.8	77.0	370.3
(F) Papaya melona	3.9	7.8	53.2	76.7
(F) Red mojarra fish	6.7	12.3	111.2	75.5
(F) Roast chicken branded	34.0	59.7	147.1	154.5
(F) Salmon fillets	8.7	32.2	76.2	67.8
(G) Dog food own brand	7.7	167.2	113.1	270.5
(G) Rice 5kg branded	8.5	49.8	62.7	121.5
(G) Soya oil X 3000cm3 own brand	3.6	51.2	64.0	162.3
(G) Sugar 2.5kg own brand	6.5	51.9	66.4	148.3
(G) Toilet paper 12 rolls own brand	4.5	35.6	48.1	106.5
(H) Bedspread	9.4	264.0	151.2	271.8
(H) Pillow branded 1 50X70	12.4	681.2	174.0	698.4
(H) Pillow branded 1 65X45	22.9	1,003.2	525.5	1,003.2
(H) Pressure cooker 6lt branded	14.5	126.0	104.1	150.3
(H) Set of two towels branded	17.2	1,003.2	229.9	1,081.9
(O) Car battery own brand	7.5	104.5	71.5	112.6
(O) Printer paper 75gr	14.7	161.8	87.3	166.2
(O) Tyres R13	14.1	150.3	78.4	165.7

Note: Implied duration (in days) is calculated as the inverse of the frequency of a change in the corresponding price or cost. All products have between 51,796 and 55,174 observations giving a total of 1,812,860.

Table 7: Symmetric and asymmetric error correction models

Product	Symmetric model			Asymmetric model				
	ect_{t-1}	s.e.	F test	$ect_{t-1}^{(+)}$	s.e.	$ect_{t-1}^{(-)}$	s.e.	F test
(F) Beef (minute steak)	-0.08	0.03	0.00	0.03	0.03	-0.33	0.08	0.00
(F) Beef (ribs)	-0.08	0.02	0.00	-0.13	0.04	-0.06	0.04	0.00
(F) Beef (rump steak assisted sale)	-0.16	0.03	0.00	0.02	0.05	-0.34	0.07	0.00
(F) Beef (rump steak)	-0.24	0.04	0.00	-0.14	0.05	-0.34	0.07	0.00
(F) Beef (sirloin)	-0.11	0.03	0.00	-0.03	0.04	-0.20	0.07	0.00
(F) Beef (thick flank)	-0.22	0.04	0.00	-0.14	0.04	-0.30	0.08	0.00
(F) Catfish fillets (imported)	-0.09	0.02	0.00	-0.01	0.04	-0.21	0.08	0.00
(F) Chicken breast	-0.06	0.03	0.00	0.01	0.04	-0.10	0.05	0.00
(F) Chicken breast with skin own brand	-0.01	0.00	0.00	0.00	0.01	-0.01	0.01	0.00
(F) Cooked prawn assisted sale	-0.18	0.03	0.00	-0.14	0.08	-0.19	0.06	0.00
(F) Eggs 30 units red branded 1	-0.05	0.03	0.00	-0.06	0.04	-0.05	0.04	0.00
(F) Full fat milk own brand (6X900ml)	-0.13	0.02	0.00	0.03	0.03	-0.28	0.05	0.00
(F) Lactose-free milk branded 1 (6X1100ml)	-0.17	0.04	0.00	0.01	0.05	-0.34	0.07	0.00
(F) Lactose-free milk branded 2 UHT (4X946ml)	-0.07	0.02	0.00	-0.12	0.04	-0.04	0.03	0.00
(F) Lactose-free milk branded 3 (6X1300ml)	-0.13	0.08	0.00	0.33	0.07	-0.31	0.08	0.00
(F) Packet of sausages 500gr branded	-0.19	0.04	0.00	0.10	0.05	-0.43	0.08	0.00
(F) Papaya melona	-0.30	0.04	0.00	-0.25	0.07	-0.34	0.07	0.00
(F) Red mojarra fish	-0.23	0.04	0.00	-0.23	0.08	-0.24	0.07	0.00
(F) Roast chicken branded	-0.04	0.01	0.00	-0.04	0.03	-0.04	0.02	0.00
(F) Salmon fillets	-0.10	0.02	0.00	-0.06	0.04	-0.14	0.05	0.00
(G) Dog food own brand	-0.08	0.02	0.00	0.06	0.04	-0.34	0.09	0.00
(G) Rice 5kg branded	-0.05	0.01	0.00	-0.03	0.03	-0.06	0.02	0.00
(G) Soya oil X 3000cm3 own brand	-0.09	0.02	0.00	-0.07	0.04	-0.10	0.03	0.00
(G) Sugar 2.5kg own brand	-0.11	0.02	0.00	-0.06	0.04	-0.13	0.04	0.00
(G) Toilet paper 12 rolls own brand	-0.11	0.02	0.00	-0.09	0.05	-0.12	0.04	0.00
(H) Bedspread	-0.05	0.02	0.00	-0.15	0.04	-0.02	0.02	0.00
(H) Pillow branded 1 50X70	-0.09	0.04	0.00	-0.29	0.13	-0.06	0.06	0.00
(H) Pillow branded 1 65X45	-0.13	0.05	0.00	0.29	0.13	-0.25	0.11	0.00
(H) Pressure cooker 6lt branded	-0.07	0.02	0.00	-0.05	0.05	-0.09	0.06	0.00
(H) Set of two towels branded	-0.02	0.01	0.00	-0.03	0.03	-0.01	0.04	0.00
(O) Car battery own brand	-0.06	0.01	0.00	-0.03	0.03	-0.08	0.03	0.00
(O) Printer paper 75gr	-0.04	0.01	0.00	0.03	0.02	-0.16	0.04	0.00
(O) Tyres R13	-0.05	0.01	0.00	-0.03	0.03	-0.07	0.03	0.00

Note: Standards errors are HAC (see Newey and West (1987)). F test is the p-value of the test for the joint significance of all included regressors (except the intercept). All product regressions have between 1,119 and 1,125 observations, include intercept, and the number of lags of Δp_t and lags of Δc_t is determined by the Schwartz information criterion.

Table 8: Symmetry test and persistence analysis

Product	Symmetry test				
	Fstat.	p-value	hlife	hlife$^+$	hlife$^-$
(F) Beef (minute steak)	13.1	0.00		n.a.	1.7
(F) Beef (ribs)	1.3	0.26	8.0		
(F) Beef (rump steak assisted sale)	15.6	0.00		n.a.	1.6
(F) Beef (rump steak)	4.4	0.04		4.5	1.7
(F) Beef (sirloin)	3.5	0.06	5.7		
(F) Beef (thick flank)	2.1	0.15	2.8		
(F) Catfish fillets (imported)	2.9	0.09	7.7		
(F) Chicken breast	2.5	0.11	10.3		
(F) Chicken breast with skin own brand	1.3	0.26	94.6		
(F) Cooked prawn assisted sale	0.1	0.71	3.6		
(F) Eggs 30 units red branded 1	0.1	0.77	13.2		
(F) Full fat milk own brand (6X900ml)	19.1	0.00		n.a.	2.1
(F) Lactose-free milk branded 1 (6X1100ml)	13.9	0.00		n.a.	1.7
(F) Lactose-free milk branded 2 UHT (4X946ml)	2.2	0.14	9.9		
(F) Lactose-free milk branded 3 (6X1300ml)	32.1	0.00		n.a.	1.9
(F) Packet of sausages 500gr branded	23.9	0.00		n.a.	1.2
(F) Papaya melona	0.6	0.45	1.9		
(F) Red mojarra fish	0.0	0.96	2.6		
(F) Roast chicken branded	0.0	0.94	16.8		
(F) Salmon fillets	1.1	0.30	6.4		
(G) Dog food own brand	9.8	0.00		n.a.	1.7
(G) Rice 5kg branded	0.3	0.56	14.1		
(G) Soya oil X 3000cm3 own brand	0.4	0.51	7.1		
(G) Sugar 2.5kg own brand	1.3	0.26	6.0		
(G) Toilet paper 12 rolls own brand	0.2	0.68	6.1		
(H) Bedspread	5.8	0.02		4.2	35.5
(H) Pillow branded 1 50X70	1.8	0.18	7.0		
(H) Pillow branded 1 65X45	5.8	0.02		n.a.	2.4
(H) Pressure cooker 6lt branded	0.1	0.72	9.8		
(H) Set of two towels branded	0.2	0.65	33.0		
(O) Car battery own brand	0.6	0.45	12.2		
(O) Printer paper 75gr	11.7	0.00		n.a.	4.1
(O) Tyres R13	0.7	0.39	12.5		

Note: The half life of a shock is measured in days. "n.a." indicates that the concept of half life is not applicable because $\hat{\delta}$ is outside the interval $(0, -1)$.

A Appendix: Results for Bogotá

Table A.1: Fraction of days price (cost) spent at, below or above reference price (cost) (Bogotá)

Product	Same		Below		Above	
	p	c	p	c	p	c
All products	0.74	0.91	0.18	0.05	0.08	0.04
(F) Beef (minute steak)	0.70	0.91	0.26	0.05	0.04	0.05
(F) Beef (ribs)	0.65	0.90	0.28	0.07	0.07	0.03
(F) Beef (rump steak assisted sale)	0.65	0.89	0.26	0.06	0.09	0.05
(F) Beef (rump steak)	0.58	0.88	0.34	0.07	0.08	0.06
(F) Beef (sirloin)	0.65	0.89	0.31	0.05	0.04	0.06
(F) Beef (thick flank)	0.63	0.90	0.28	0.05	0.08	0.05
(F) Catfish fillets (imported)	0.82	0.85	0.12	0.07	0.06	0.07
(F) Chicken breast	0.88	0.98	0.10	0.01	0.02	0.01
(F) Chicken breast with skin own brand	0.74	0.97	0.21	0.02	0.05	0.00
(F) Cooked prawn assisted sale	0.71	0.79	0.23	0.11	0.07	0.10
(F) Eggs 30 units red branded 1	0.84	0.93	0.10	0.04	0.06	0.03
(F) Full fat milk own brand (6X900ml)	0.63	0.84	0.24	0.08	0.13	0.08
(F) Lactose-free milk branded 1 (6X1100ml)	0.69	0.95	0.20	0.02	0.12	0.03
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.70	0.95	0.15	0.03	0.15	0.02
(F) Lactose-free milk branded 3 (6X1300ml)	0.89	0.99	0.06	0.00	0.06	0.01
(F) Packet of sausages 500gr branded	0.71	0.97	0.16	0.01	0.13	0.02
(F) Papaya melona	0.63	0.73	0.22	0.17	0.15	0.11
(F) Red mojarra fish	0.73	0.71	0.22	0.15	0.04	0.13
(F) Roast chicken branded	0.91	0.92	0.04	0.04	0.05	0.04
(F) Salmon fillets	0.76	0.78	0.18	0.12	0.06	0.10
(G) Dog food own brand	0.81	0.96	0.14	0.02	0.05	0.02
(G) Rice 5kg branded	0.64	0.90	0.20	0.05	0.17	0.06
(G) Soya oil X 3000cm3 own brand	0.66	0.90	0.25	0.07	0.09	0.03
(G) Sugar 2.5kg own brand	0.71	0.93	0.18	0.03	0.10	0.04
(G) Toilet paper 12 rolls own brand	0.64	0.89	0.18	0.04	0.18	0.07
(H) Bedspread	0.78	0.96	0.19	0.03	0.03	0.01
(H) Pillow branded 1 50X70	0.87	0.99	0.11	0.01	0.02	0.00
(H) Pillow branded 1 65X45	0.94	0.99	0.05	0.00	0.01	0.01
(H) Pressure cooker 6lt branded	0.81	0.94	0.12	0.02	0.07	0.04
(H) Set of two towels branded	0.89	0.99	0.09	0.01	0.03	0.00
(O) Car battery own brand	0.69	0.92	0.22	0.04	0.08	0.03
(O) Printer paper 75gr	0.81	0.95	0.12	0.02	0.07	0.03
(O) Tyres R13	0.79	0.94	0.13	0.03	0.08	0.03

Note: All products have between 12,397 and 14,651 observations giving a total of 480,102.

Table A.2: Fraction of months in which daily prices (costs) are constant for the whole month (Bogotá)

Product	Price	Cost
All products	0.22	0.69
(F) Beef (minute steak)	0.03	0.65
(F) Beef (ribs)	0.03	0.64
(F) Beef (rump steak assisted sale)	0.16	0.63
(F) Beef (rump steak)	0.04	0.57
(F) Beef (sirloin)	0.04	0.61
(F) Beef (thick flank)	0.03	0.67
(F) Catfish fillets (imported)	0.23	0.53
(F) Chicken breast	0.62	0.90
(F) Chicken breast with skin own brand	0.26	0.87
(F) Cooked prawn assisted sale	0.12	0.33
(F) Eggs 30 units red branded 1	0.44	0.73
(F) Full fat milk own brand (6X900ml)	0.04	0.44
(F) Lactose-free milk branded 1 (6X1100ml)	0.06	0.86
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.05	0.79
(F) Lactose-free milk branded 3 (6X1300ml)	0.65	0.95
(F) Packet of sausages 500gr branded	0.07	0.89
(F) Papaya melona	0.05	0.08
(F) Red mojarra fish	0.08	0.12
(F) Roast chicken branded	0.57	0.66
(F) Salmon fillets	0.26	0.35
(G) Dog food own brand	0.47	0.86
(G) Rice 5kg branded	0.12	0.65
(G) Soya oil X 3000cm3 own brand	0.07	0.72
(G) Sugar 2.5kg own brand	0.13	0.79
(G) Toilet paper 12 rolls own brand	0.12	0.59
(H) Bedspread	0.14	0.88
(H) Pillow branded 1 50X70	0.27	0.95
(H) Pillow branded 1 65X45	0.58	0.97
(H) Pressure cooker 6lt branded	0.25	0.74
(H) Set of two towels branded	0.39	0.97
(O) Car battery own brand	0.14	0.70
(O) Printer paper 75gr	0.35	0.80
(O) Tyres R13	0.32	0.80

Note: All products have between 12,386 and 14,638 observations giving a total of 479,676.

Table A.3: Prob. of price (reference price) changing when cost (reference cost) does not change (Bogotá)

Product	Price	Reference price
All products	0.17	0.01
(F) Beef (minute steak)	0.33	0.01
(F) Beef (ribs)	0.31	0.01
(F) Beef (rump steak assisted sale)	0.29	0.01
(F) Beef (rump steak)	0.37	0.01
(F) Beef (sirloin)	0.35	0.01
(F) Beef (thick flank)	0.32	0.01
(F) Catfish fillets (imported)	0.11	0.00
(F) Chicken breast	0.10	0.00
(F) Chicken breast with skin own brand	0.23	0.01
(F) Cooked prawn assisted sale	0.18	0.00
(F) Eggs 30 units red branded 1	0.08	0.01
(F) Full fat milk own brand (6X900ml)	0.19	0.01
(F) Lactose-free milk branded 1 (6X1100ml)	0.15	0.01
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.14	0.01
(F) Lactose-free milk branded 3 (6X1300ml)	0.04	0.01
(F) Packet of sausages 500gr branded	0.16	0.01
(F) Papaya melona	0.23	0.01
(F) Red mojarra fish	0.14	0.00
(F) Roast chicken branded	0.03	0.00
(F) Salmon fillets	0.11	0.00
(G) Dog food own brand	0.14	0.01
(G) Rice 5kg branded	0.15	0.01
(G) Soya oil X 3000cm3 own brand	0.24	0.01
(G) Sugar 2.5kg own brand	0.14	0.01
(G) Toilet paper 12 rolls own brand	0.21	0.01
(H) Bedspread	0.13	0.01
(H) Pillow branded 1 50X70	0.09	0.01
(H) Pillow branded 1 65X45	0.05	0.00
(H) Pressure cooker 6lt branded	0.08	0.01
(H) Set of two towels branded	0.07	0.00
(O) Car battery own brand	0.16	0.01
(O) Printer paper 75gr	0.07	0.01
(O) Tyres R13	0.07	0.01

Note: All products have between 12,386 and 14,638 observations giving a total of 479,676.

Table A.4: Transition matrices for prices (p) and costs (c) (Bogotá)

Product	NR to NR		NR to R		R to NR		R to R	
	p	c	p	c	p	c	p	c
All products	0.72	0.85	0.28	0.15	0.10	0.02	0.91	0.98
(F) Beef (minute steak)	0.50	0.89	0.50	0.11	0.21	0.01	0.79	0.99
(F) Beef (ribs)	0.63	0.90	0.37	0.10	0.20	0.01	0.80	0.99
(F) Beef (rump steak assisted sale)	0.68	0.88	0.32	0.12	0.17	0.02	0.83	0.98
(F) Beef (rump steak)	0.66	0.88	0.34	0.12	0.25	0.02	0.75	0.98
(F) Beef (sirloin)	0.59	0.89	0.41	0.11	0.22	0.01	0.78	0.99
(F) Beef (thick flank)	0.64	0.88	0.36	0.12	0.21	0.01	0.79	0.99
(F) Catfish fillets (imported)	0.69	0.88	0.31	0.12	0.07	0.02	0.93	0.98
(F) Chicken breast	0.62	0.85	0.38	0.15	0.05	0.00	0.95	1.00
(F) Chicken breast with skin own brand	0.62	0.86	0.38	0.14	0.13	0.00	0.87	1.00
(F) Cooked prawn assisted sale	0.74	0.86	0.26	0.14	0.11	0.04	0.89	0.96
(F) Eggs 30 units red branded 1	0.77	0.87	0.23	0.13	0.05	0.01	0.95	0.99
(F) Full fat milk own brand (6X900ml)	0.77	0.80	0.23	0.20	0.13	0.04	0.87	0.96
(F) Lactose-free milk branded 1 (6X1100ml)	0.80	0.81	0.20	0.19	0.09	0.01	0.91	0.99
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.79	0.82	0.21	0.18	0.09	0.01	0.91	0.99
(F) Lactose-free milk branded 3 (6X1300ml)	0.84	0.94	0.16	0.06	0.02	0.00	0.98	1.00
(F) Packet of sausages 500gr branded	0.76	0.76	0.24	0.24	0.10	0.01	0.90	0.99
(F) Papaya melona	0.67	0.73	0.33	0.27	0.20	0.10	0.80	0.90
(F) Red mojarra fish	0.73	0.80	0.27	0.20	0.10	0.08	0.90	0.92
(F) Roast chicken branded	0.77	0.86	0.23	0.14	0.02	0.01	0.98	0.99
(F) Salmon fillets	0.79	0.88	0.21	0.12	0.07	0.03	0.93	0.97
(G) Dog food own brand	0.75	0.87	0.25	0.13	0.06	0.01	0.94	1.00
(G) Rice 5kg branded	0.84	0.87	0.16	0.13	0.09	0.02	0.91	0.98
(G) Soya oil X 3000cm3 own brand	0.70	0.88	0.30	0.12	0.15	0.01	0.85	0.99
(G) Sugar 2.5kg own brand	0.78	0.84	0.22	0.16	0.09	0.01	0.91	0.99
(G) Toilet paper 12 rolls own brand	0.78	0.85	0.22	0.15	0.12	0.02	0.88	0.98
(H) Bedspread	0.78	0.91	0.22	0.09	0.06	0.00	0.94	1.00
(H) Pillow branded 1 50X70	0.70	0.87	0.30	0.13	0.05	0.00	0.95	1.00
(H) Pillow branded 1 65X45	0.64	0.89	0.36	0.11	0.02	0.00	0.98	1.00
(H) Pressure cooker 6lt branded	0.80	0.87	0.20	0.13	0.05	0.01	0.95	0.99
(H) Set of two towels branded	0.73	0.90	0.27	0.10	0.04	0.00	0.96	1.00
(O) Car battery own brand	0.80	0.88	0.20	0.12	0.09	0.01	0.91	0.99
(O) Printer paper 75gr	0.83	0.87	0.17	0.13	0.04	0.01	0.96	0.99
(O) Tyres R13	0.85	0.90	0.15	0.10	0.04	0.01	0.96	0.99

Note: NR and R denote non-reference and reference, respectively. All products have between 12,386 and 14,638 observations giving a total of 479,676.

Table A.5: Mean and standard deviation of actual and reference daily markups (Bogotá)

Product	Actual		Reference	
	Mean	s.d.	Mean	s.d.
All products	0.28	0.24	0.31	0.23
(F) Beef (minute steak)	0.20	0.16	0.25	0.13
(F) Beef (ribs)	0.14	0.19	0.19	0.16
(F) Beef (rump steak assisted sale)	0.23	0.15	0.27	0.13
(F) Beef (rump steak)	0.17	0.14	0.22	0.10
(F) Beef (sirloin)	0.23	0.15	0.30	0.11
(F) Beef (thick flank)	0.14	0.13	0.18	0.10
(F) Catfish fillets (imported)	0.58	0.27	0.60	0.28
(F) Chicken breast	0.32	0.15	0.35	0.12
(F) Chicken breast with skin own brand	0.35	0.20	0.39	0.18
(F) Cooked prawn assisted sale	0.54	0.19	0.59	0.16
(F) Eggs 30 units red branded 1	0.01	0.15	0.02	0.15
(F) Full fat milk own brand (6X900ml)	0.01	0.12	0.03	0.11
(F) Lactose-free milk branded 1 (6X1100ml)	0.10	0.08	0.12	0.10
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.03	0.12	0.02	0.12
(F) Lactose-free milk branded 3 (6X1300ml)	0.14	0.03	0.14	0.03
(F) Packet of sausages 500gr branded	0.23	0.09	0.24	0.08
(F) Papaya melona	0.26	0.33	0.24	0.30
(F) Red mojarra fish	0.26	0.15	0.30	0.13
(F) Roast chicken branded	0.29	0.12	0.29	0.12
(F) Salmon fillets	0.23	0.16	0.25	0.16
(G) Dog food own brand	0.38	0.14	0.40	0.14
(G) Rice 5kg branded	0.05	0.10	0.06	0.10
(G) Soya oil X 3000cm3 own brand	0.24	0.12	0.27	0.11
(G) Sugar 2.5kg own brand	0.16	0.19	0.19	0.20
(G) Toilet paper 12 rolls own brand	0.28	0.20	0.28	0.18
(H) Bedspread	0.41	0.22	0.46	0.18
(H) Pillow branded 1 50X70	0.58	0.17	0.60	0.16
(H) Pillow branded 1 65X45	0.71	0.12	0.73	0.10
(H) Pressure cooker 6lt branded	0.43	0.15	0.44	0.14
(H) Set of two towels branded	0.55	0.23	0.57	0.22
(O) Car battery own brand	0.41	0.16	0.44	0.17
(O) Printer paper 75gr	0.38	0.17	0.39	0.16
(O) Tyres R13	0.29	0.12	0.30	0.12

Note: All products have between 12,397 and 14,651 observations giving a total of 480,102.

Table A.6: Implied duration of actual and reference price and cost changes (Bogotá)

Product	Actual		Reference	
	p	c	p	c
All products	5.7	39.5	82.7	125.2
(F) Beef (minute steak)	2.9	72.5	74.7	108.4
(F) Beef (ribs)	3.2	80.9	86.1	97.6
(F) Beef (rump steak assisted sale)	3.4	51.4	62.6	90.4
(F) Beef (rump steak)	2.6	46.5	60.2	79.6
(F) Beef (sirloin)	2.8	68.4	65.6	95.1
(F) Beef (thick flank)	3.0	75.8	63.9	89.3
(F) Catfish fillets (imported)	8.2	32.0	160.9	90.9
(F) Chicken breast	9.4	162.6	252.4	542.2
(F) Chicken breast with skin own brand	4.3	173.2	142.2	409.5
(F) Cooked prawn assisted sale	5.0	17.6	106.8	64.8
(F) Eggs 30 units red branded 1	11.0	70.7	81.8	121.0
(F) Full fat milk own brand (6X900ml)	4.3	15.1	63.4	80.0
(F) Lactose-free milk branded 1 (6X1100ml)	5.9	44.1	64.2	206.2
(F) Lactose-free milk branded 2 UHT (4X946ml)	6.2	46.5	48.6	134.3
(F) Lactose-free milk branded 3 (6X1300ml)	22.7	563.0	160.9	1,126.0
(F) Packet of sausages 500gr branded	5.9	54.8	69.4	357.0
(F) Papaya melona	3.6	6.9	44.6	65.1
(F) Red mojarra fish	6.0	8.2	125.1	62.3
(F) Roast chicken branded	25.7	49.0	143.5	147.9
(F) Salmon fillets	7.9	21.1	86.1	58.8
(G) Dog food own brand	7.1	160.9	106.1	256.8
(G) Rice 5kg branded	6.0	34.8	53.0	102.4
(G) Soya oil X 3000cm3 own brand	3.9	42.7	64.2	144.9
(G) Sugar 2.5kg own brand	6.3	44.6	67.5	139.4
(G) Toilet paper 12 rolls own brand	4.3	27.8	46.3	95.7
(H) Bedspread	7.9	244.0	152.5	244.0
(H) Pillow branded 1 50X70	10.9	636.4	154.1	636.4
(H) Pillow branded 1 65X45	21.9	975.9	443.6	975.9
(H) Pressure cooker 6lt branded	12.0	101.7	109.2	130.7
(H) Set of two towels branded	14.9	861.0	225.2	975.9
(O) Car battery own brand	5.9	98.9	69.4	105.3
(O) Printer paper 75gr	13.2	146.4	80.9	146.4
(O) Tyres R13	13.9	146.4	69.0	159.1

Note: Implied duration (in days) is calculated as the inverse of the frequency of a change in the corresponding price or cost. All products have between 12,386 and 14,638 observations giving a total of 479,676.

Table A.7: Symmetric and asymmetric error correction models (Bogotá)

Product	Symmetric model			Asymmetric model				
	ect_{t-1}	s.e.	F test	$ect_{t-1}^{(+)}$	s.e.	$ect_{t-1}^{(-)}$	s.e.	F test
(F) Beef (minute steak)	-0.07	0.03	0.00	0.05	0.03	-0.34	0.10	0.00
(F) Beef (ribs)	-0.08	0.02	0.00	-0.13	0.04	-0.05	0.04	0.00
(F) Beef (rump steak assisted sale)	-0.16	0.03	0.00	-0.05	0.04	-0.29	0.06	0.00
(F) Beef (rump steak)	-0.22	0.04	0.00	-0.08	0.05	-0.37	0.07	0.00
(F) Beef (sirloin)	-0.10	0.03	0.00	0.00	0.04	-0.18	0.06	0.00
(F) Beef (thick flank)	-0.22	0.04	0.00	-0.11	0.04	-0.33	0.07	0.00
(F) Catfish fillets (imported)	-0.12	0.02	0.00	-0.05	0.06	-0.22	0.09	0.00
(F) Chicken breast	-0.18	0.05	0.00	0.05	0.08	-0.27	0.08	0.00
(F) Chicken breast with skin own brand	-0.16	0.03	0.00	-0.07	0.04	-0.22	0.06	0.00
(F) Cooked prawn assisted sale	-0.16	0.03	0.00	0.03	0.05	-0.28	0.05	0.00
(F) Eggs 30 units red branded 1	-0.06	0.02	0.00	-0.09	0.05	-0.04	0.04	0.00
(F) Full fat milk own brand (6X900ml)	-0.15	0.02	0.00	0.04	0.04	-0.35	0.06	0.00
(F) Lactose-free milk branded 1 (6X1100ml)	-0.16	0.04	0.00	0.05	0.04	-0.38	0.06	0.00
(F) Lactose-free milk branded 2 UHT (4X946ml)	-0.11	0.02	0.00	-0.15	0.05	-0.09	0.04	0.00
(F) Lactose-free milk branded 3 (6X1300ml)	-0.11	0.06	0.00	0.17	0.07	-0.22	0.09	0.00
(F) Packet of sausages 500gr branded	-0.15	0.04	0.00	0.06	0.04	-0.28	0.08	0.00
(F) Papaya melona	-0.25	0.03	0.00	-0.18	0.05	-0.33	0.06	0.00
(F) Red mojarra fish	-0.21	0.04	0.00	-0.19	0.07	-0.23	0.07	0.00
(F) Roast chicken branded	-0.05	0.01	0.00	-0.04	0.03	-0.05	0.02	0.00
(F) Salmon fillets	-0.10	0.02	0.00	-0.04	0.05	-0.15	0.05	0.00
(G) Dog food own brand	-0.08	0.02	0.00	0.08	0.04	-0.39	0.10	0.00
(G) Rice 5kg branded	-0.15	0.02	0.00	-0.14	0.07	-0.15	0.06	0.00
(G) Soya oil X 3000cm3 own brand	-0.11	0.02	0.00	-0.05	0.04	-0.14	0.04	0.00
(G) Sugar 2.5kg own brand	-0.12	0.02	0.00	-0.04	0.04	-0.17	0.04	0.00
(G) Toilet paper 12 rolls own brand	-0.12	0.02	0.00	-0.12	0.05	-0.12	0.03	0.00
(H) Bedspread	-0.06	0.02	0.00	-0.16	0.05	-0.03	0.03	0.00
(H) Pillow branded 1 50X70	-0.14	0.06	0.00	-0.25	0.11	-0.12	0.08	0.00
(H) Pillow branded 1 65X45	-0.12	0.04	0.00	0.31	0.11	-0.27	0.10	0.00
(H) Pressure cooker 6lt branded	-0.08	0.02	0.00	-0.03	0.05	-0.13	0.06	0.00
(H) Set of two towels branded	-0.03	0.01	0.00	-0.03	0.03	-0.02	0.03	0.00
(O) Car battery own brand	-0.06	0.01	0.00	-0.03	0.03	-0.09	0.04	0.00
(O) Printer paper 75gr	-0.04	0.01	0.00	0.03	0.02	-0.15	0.03	0.00
(O) Tyres R13	-0.06	0.01	0.00	-0.05	0.03	-0.07	0.03	0.00

Note: Standards errors are HAC (see Newey and West (1987)). F test is the p-value of the test for the joint significance of all included regressors (except the intercept). All product regressions have between 1,119 and 1,125 observations, include intercept, and the number of lags of Δp_t and lags of Δc_t is determined by the Schwartz information criterion.

Table A.8: Symmetry test and persistence analysis (Bogotá)

Product	Symmetry test				
	Fstat.	p-value	hlife	hlife$^+$	hlife$^-$
(F) Beef (minute steak)	10.2	0.00		n.a.	1.7
(F) Beef (ribs)	1.4	0.24	8.1		
(F) Beef (rump steak assisted sale)	7.9	0.00		14.4	2.0
(F) Beef (rump steak)	10.5	0.00		8.5	1.5
(F) Beef (sirloin)	5.3	0.02		180.6	3.4
(F) Beef (thick flank)	5.6	0.02		6.0	1.7
(F) Catfish fillets (imported)	1.3	0.26	5.4		
(F) Chicken breast	5.8	0.02		n.a.	2.2
(F) Chicken breast with skin own brand	3.4	0.06	4.0		
(F) Cooked prawn assisted sale	12.7	0.00		n.a.	2.1
(F) Eggs 30 units red branded 1	0.4	0.54	11.3		
(F) Full fat milk own brand (6X900ml)	20.5	0.00		n.a.	1.6
(F) Lactose-free milk branded 1 (6X1100ml)	32.3	0.00		n.a.	1.5
(F) Lactose-free milk branded 2 UHT (4X946ml)	0.5	0.50	5.9		
(F) Lactose-free milk branded 3 (6X1300ml)	8.4	0.00		n.a.	2.8
(F) Packet of sausages 500gr branded	11.1	0.00		n.a.	2.1
(F) Papaya melona	2.9	0.09	2.4		
(F) Red mojarra fish	0.1	0.72	2.9		
(F) Roast chicken branded	0.1	0.77	14.4		
(F) Salmon fillets	1.8	0.18	6.6		
(G) Dog food own brand	11.6	0.00		n.a.	1.4
(G) Rice 5kg branded	0.0	0.94	4.3		
(G) Soya oil X 3000cm3 own brand	1.5	0.21	5.9		
(G) Sugar 2.5kg own brand	3.6	0.06	5.4		
(G) Toilet paper 12 rolls own brand	0.0	0.91	5.5		
(H) Bedspread	4.2	0.04		4.0	23.4
(H) Pillow branded 1 50X70	0.6	0.44	4.7		
(H) Pillow branded 1 65X45	8.5	0.00		n.a.	2.2
(H) Pressure cooker 6lt branded	0.9	0.34	8.1		
(H) Set of two towels branded	0.0	0.82	26.6		
(O) Car battery own brand	0.9	0.34	10.8		
(O) Printer paper 75gr	14.0	0.00		n.a.	4.3
(O) Tyres R13	0.2	0.62	10.5		

Note: The half life of a shock is measured in days. "n.a." indicates that the concept of half life is not applicable because $\hat{\delta}$ is outside the interval $(0, -1)$.

B Appendix: Selected results all stores except Bogotá

Table B.1: Symmetric and asymmetric error correction models (All except Bogotá)

Product	Symmetric model			Asymmetric model				
	ect_{t-1}	s.e.	F test	$ect_{t-1}^{(+)}$	s.e.	$ect_{t-1}^{(-)}$	s.e.	F test
(F) Beef (minute steak)	-0.11	0.04	0.00	0.01	0.04	-0.35	0.07	0.00
(F) Beef (ribs)	-0.08	0.02	0.00	-0.13	0.04	-0.05	0.04	0.00
(F) Beef (rump steak assisted sale)	-0.07	0.02	0.00	0.05	0.04	-0.20	0.05	0.00
(F) Beef (rump steak)	-0.22	0.04	0.00	-0.14	0.05	-0.33	0.07	0.00
(F) Beef (sirloin)	-0.13	0.03	0.00	-0.05	0.04	-0.22	0.08	0.00
(F) Beef (thick flank)	-0.21	0.04	0.00	-0.14	0.04	-0.29	0.08	0.00
(F) Catfish fillets (imported)	-0.08	0.02	0.00	-0.01	0.04	-0.19	0.08	0.00
(F) Chicken breast	-0.05	0.03	0.00	0.00	0.03	-0.08	0.05	0.00
(F) Chicken breast with skin own brand	-0.01	0.00	0.00	0.00	0.01	-0.01	0.01	0.00
(F) Cooked prawn assisted sale	-0.17	0.03	0.00	-0.13	0.06	-0.18	0.06	0.00
(F) Eggs 30 units red branded 1	-0.04	0.02	0.00	-0.03	0.04	-0.05	0.04	0.00
(F) Full fat milk own brand (6X900ml)	-0.11	0.02	0.00	0.02	0.03	-0.25	0.05	0.00
(F) Lactose-free milk branded 1 (6X1100ml)	-0.16	0.04	0.00	0.01	0.06	-0.30	0.07	0.00
(F) Lactose-free milk branded 2 UHT (4X946ml)	-0.06	0.01	0.00	-0.10	0.03	-0.04	0.02	0.00
(F) Lactose-free milk branded 3 (6X1300ml)	-0.18	0.09	0.00	0.31	0.08	-0.35	0.09	0.00
(F) Packet of sausages 500gr branded	-0.19	0.04	0.00	0.10	0.05	-0.45	0.08	0.00
(F) Papaya melona	-0.30	0.04	0.00	-0.27	0.07	-0.33	0.07	0.00
(F) Red mojarra fish	-0.24	0.04	0.00	-0.29	0.09	-0.21	0.07	0.00
(F) Roast chicken branded	-0.04	0.01	0.01	-0.03	0.04	-0.04	0.02	0.00
(F) Salmon fillets	-0.09	0.02	0.00	-0.04	0.04	-0.13	0.05	0.00
(G) Dog food own brand	-0.07	0.02	0.00	0.06	0.04	-0.31	0.09	0.00
(G) Rice 5kg branded	-0.03	0.01	0.00	-0.01	0.02	-0.04	0.02	0.00
(G) Soya oil X 3000cm3 own brand	-0.09	0.02	0.00	-0.07	0.04	-0.10	0.03	0.00
(G) Sugar 2.5kg own brand	-0.10	0.02	0.00	-0.08	0.04	-0.12	0.04	0.00
(G) Toilet paper 12 rolls own brand	-0.10	0.02	0.00	-0.08	0.05	-0.13	0.04	0.00
(H) Bedspread	-0.05	0.02	0.00	-0.15	0.04	-0.02	0.02	0.00
(H) Pillow branded 1 50X70	-0.08	0.03	0.00	-0.31	0.13	-0.04	0.05	0.00
(H) Pillow branded 1 65X45	-0.14	0.05	0.00	0.25	0.14	-0.24	0.11	0.00
(H) Pressure cooker 6lt branded	-0.06	0.02	0.00	-0.05	0.05	-0.08	0.06	0.00
(H) Set of two towels branded	-0.02	0.02	0.00	-0.04	0.03	0.00	0.04	0.00
(O) Car battery own brand	-0.05	0.01	0.00	-0.03	0.03	-0.08	0.03	0.00
(O) Printer paper 75gr	-0.05	0.01	0.00	0.03	0.02	-0.16	0.04	0.00
(O) Tyres R13	-0.05	0.01	0.00	-0.02	0.03	-0.08	0.03	0.00

Note: Standards errors are HAC (see Newey and West (1987)). F test is the p-value of the test for the joint significance of all included regressors (except the intercept). All product regressions have between 1,119 and 1,125 observations, include intercept, and the number of lags of Δp_t and lags of Δc_t is determined by the Schwartz information criterion.

Table B.2: Symmetry test and persistence analysis (All except Bogotá)

Product	Symmetry test				
	Fstat.	p-value	hlife	hlife$^+$	hlife$^-$
(F) Beef (minute steak)	17.2	0.00		n.a.	1.6
(F) Beef (ribs)	1.4	0.24	8.5		
(F) Beef (rump steak assisted sale)	10.9	0.00		n.a.	3.2
(F) Beef (rump steak)	5.2	0.02		4.7	1.7
(F) Beef (sirloin)	3.0	0.08	5.1		
(F) Beef (thick flank)	1.8	0.18	3.0		
(F) Catfish fillets (imported)	2.6	0.11	8.5		
(F) Chicken breast	1.3	0.26	13.1		
(F) Chicken breast with skin own brand	1.3	0.25	128.6		
(F) Cooked prawn assisted sale	0.3	0.60	3.8		
(F) Eggs 30 units red branded 1	0.1	0.80	15.6		
(F) Full fat milk own brand (6X900ml)	16.1	0.00		n.a.	2.5
(F) Lactose-free milk branded 1 (6X1100ml)	9.3	0.00		n.a.	2.0
(F) Lactose-free milk branded 2 UHT (4X946ml)	1.8	0.18	11.9		
(F) Lactose-free milk branded 3 (6X1300ml)	26.1	0.00		n.a.	1.6
(F) Packet of sausages 500gr branded	30.2	0.00		n.a.	1.2
(F) Papaya melona	0.3	0.61	1.9		
(F) Red mojarra fish	0.3	0.56	2.5		
(F) Roast chicken branded	0.0	0.97	19.4		
(F) Salmon fillets	1.6	0.20	7.6		
(G) Dog food own brand	9.0	0.00		n.a.	1.8
(G) Rice 5kg branded	1.2	0.27	22.9		
(G) Soya oil X 3000cm3 own brand	0.2	0.67	7.5		
(G) Sugar 2.5kg own brand	0.3	0.57	6.3		
(G) Toilet paper 12 rolls own brand	0.4	0.51	6.5		
(H) Bedspread	6.0	0.01		4.4	34.6
(H) Pillow branded 1 50X70	2.5	0.11	8.1		
(H) Pillow branded 1 65X45	4.6	0.03		n.a.	2.5
(H) Pressure cooker 6lt branded	0.1	0.81	10.5		
(H) Set of two towels branded	0.3	0.56	34.3		
(O) Car battery own brand	0.6	0.43	12.4		
(O) Printer paper 75gr	10.5	0.00		n.a.	4.1
(O) Tyres R13	1.2	0.27	13.1		

Note: The half life of a shock is measured in days. "n.a." indicates that the concept of half life is not applicable because $\hat{\delta}$ is outside the interval $(0, -1)$.